Stellar radiation and particle induced ion-escape from CO2-rich Earth-size and mass exoplanets within the habitable zones of dwarf stars

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For modelling CO2 rich thermospheres within the habitable zones (HZ) of active dwarf stars over their history we apply a diffusive-gravitational equilibrium and thermal balance model and investigate the heating of the thermosphere by photodissociation and ionization processes, due to exothermic chemical reactions and cooling by CO2 IR emission in the 15 um band. Our model simulations result in expanded thermospheres. Moreover, our results yield high exospheric temperatures of several thousand Kelvin during the active phase of the dwarf stars even if we assume a "dry" CO2 atmosphere with similar composition that is observed on present Venus. For studying how much of the ionized part of the upper atmosphere could have been lost to space due to a stronger solar wind and higher X-ray and EUV fluxes we used our modelled atmospheric density profiles and studied the loss of ions from the upper atmosphere over the planet's history by applying a 3-D magnetohydrodynamic (MHD) model as well as a numerical test particle model. Depending on the used stellar wind plasma parameters, which are related to the orbital distance of the HZ our model simulations show that ion loss could remove tens or even tens of bar or even more of an atmosphere over a planet's lifetime.